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Lund, Rasmus Søgaard; Sperling, Karl; Mathiesen, Brian Vad; Connolly, David

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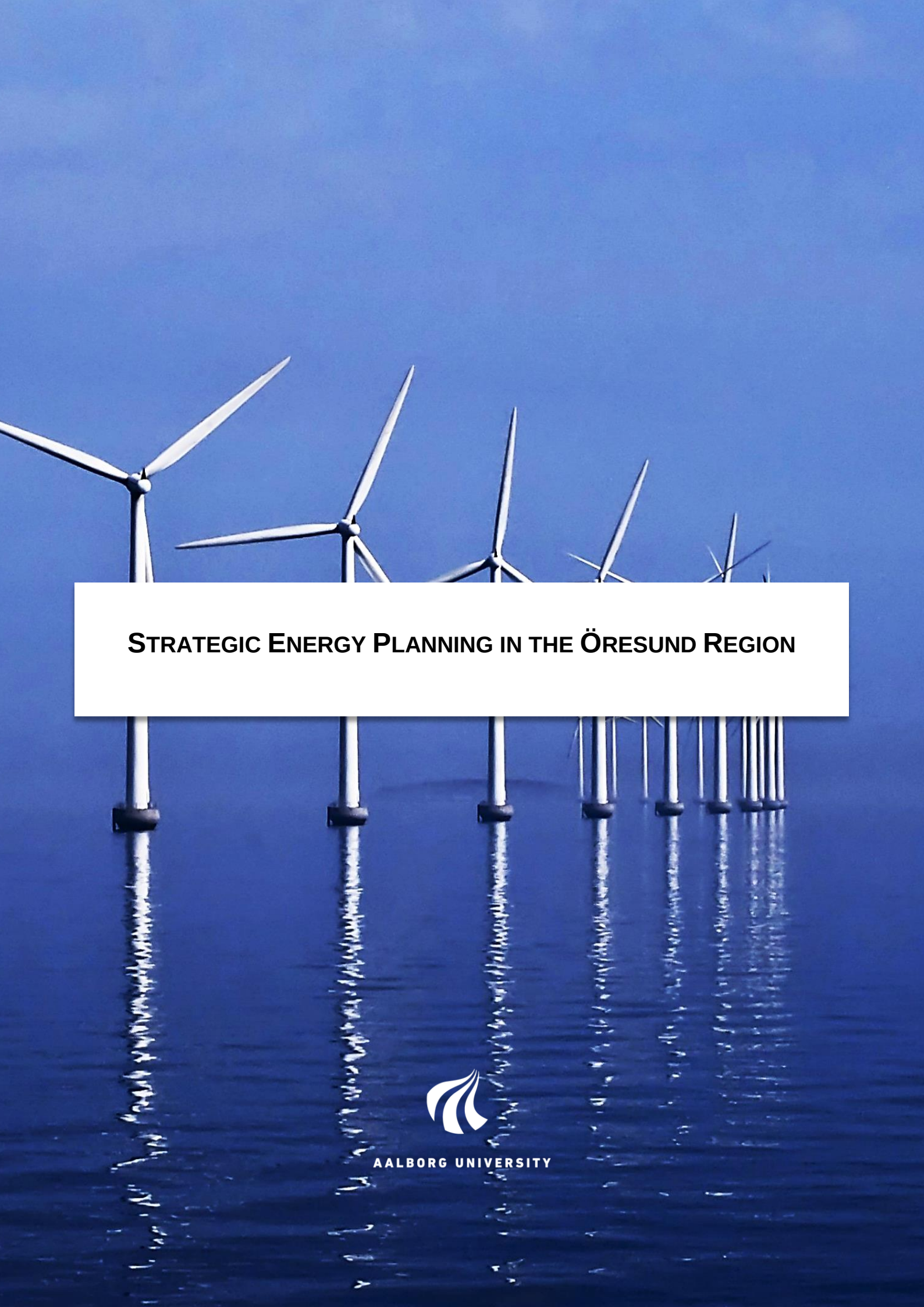

STRATEGIC ENERGY PLANNING IN THE ÖRESUND REGION

AALBORG UNIVERSITY

Strategic Energy Planning in the Öresund Region

November, 2013

© The Authors:

Rasmus Lund

Karl Sperling

Brian Vad Mathiesen

David Connolly

Aalborg University
Department of Development and Planning

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Abstract

In this project the municipalities' role in the transition to a renewable energy system is studied. For the study municipalities in Sweden and Denmark located in the Öresund Region have been chosen as cases. A number of interviews have been carried out to give the perspective of municipal planning on the national goals and direction of development and the municipalities' role and potential to act in this context.

The results contain a number of policy recommendations to improve the municipalities' ability to do strategic energy planning (SEP) e.g. in Sweden to have more ambitious goals and in Denmark to have requirements of doing SEP. A number of areas with potential knowledge transfer have also been identified. For example to use the Swedish experience with environmental assessment of energy plans in Denmark or to use the Danish experience with a progression in time in the building energy codes in Sweden.

This report is prepared as a part of Energi Øresund project

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Table of Contents

1 Introduction

In this chapter the background of the problem and the problem area are briefly introduced. Hereafter the focus of this project is presented and lastly the content of the project report is summarised.

1.1 Background

Sweden and Denmark both have tradition of doing energy planning in the municipalities, even though with different focus and measures. In Denmark the focus has been on development of district heating, CHP systems and the later decades on wind power as well. In Sweden the planning has been more focused on converting fossil fuel based heating to biomass, biogas in transport and electricity for heating.

The current development of international and national policies towards more renewable energy in the energy supply and reductions of greenhouse gasses are changing the framework for the municipalities as well and creating a new situation for their energy planning. Some have not yet taken initiative to change policy or practices, but others have already been working actively with renewable energy and climate issues for many years.

Traditionally energy has been produced centrally at power plants or oil refineries and from here distributed to the consumers of the energy via electricity grids and fuel distribution systems. Future renewable energy systems will have to be much more decentralised to use the available resources as efficiently as possible. It is also important to use the scarce resources as efficiently as possible and reduce the energy losses in the production and supply chains, for example by introducing district heating using CHP. The integration of renewable energy is to a much higher extent than fossil fuels connected to the local areas. Solar thermal, heat savings, on-shore wind turbines, geothermal energy, biogas production and utilisation of waste heat from industry are all examples of this. This means that the municipalities will have to play an important role in the development towards the renewable energy systems.

This means that the municipalities will have to take a number of new tasks compared to earlier, but it is unknown to which extent and how the municipalities are approaching these new tasks and roles. It is also not known to what extent the municipalities have the proper framework conditions for taking this role and doing these tasks. If the municipalities do not have a suitable framework to enable the municipalities to do so they will hardly be able to fulfil this role and the development in the municipalities may not develop as needed. Therefore it is relevant to study framework the municipalities have to work within and how municipalities work within this framework.

Energi Öresund is a cross bordering project cooperation about energy planning and research between municipalities, energy companies, universities and other organisations in the Öresund Region. In this context a number of different projects providing analyses of specific technologies, incentive and policies, potential solutions to specific regional problems and case studies have been carried out. This project is a contribution to the previous studies performed by giving the perspective of the municipalities on the national goals and the potential of the municipalities in doing strategic energy planning.

1.2 Project Focus

This project studies the role of the municipalities in the development towards renewable energy systems and what their framework for energy planning is and which challenges and good experience they have with the energy planning. This is done to be able to generate recommendations for the future development of the framework for energy planning in the municipalities.

The study will take its departure from a review of the concept of strategic energy planning to form a basis for the detailed study of the municipalities' framework. It is chosen to look at municipalities in Denmark and Sweden because they as mentioned have a tradition of energy planning and therefore might be able to give ideas for improvement of the framework also in the other country. Here the Öresund Region has been selected as the geographical area of the study and municipalities in both countries within here are selected.

The study contains a review of the planning framework for the municipalities within the energy area followed by a specific study of a number of interviews with municipal energy planners and the published energy plans and strategies by the municipalities. The inputs from the municipal energy planners and the legislative framework from each of the countries will be discussed and these will be related to the concepts of strategic energy planning.

1.3 Report Content

In Chapter 2 the methodological considerations of this study presented and discussed and the specific application of the methods literature review and interview is described. In Chapter 3 the theoretical framework for the analyses is presented and discussed with the role of the municipalities. The Chapters 4 and 5 gives respectively for Sweden and Denmark a presentation of the planning framework and the output of the interviews. Chapter 6 discusses the outputs of the interviews and the framework in the two countries and suggests possibilities of knowledge transfer between the countries, and the results are related to the theoretical concepts of SEP.

2 Methodology

In this chapter the methodology of the project is presented. First the research design and the structure of the analysis is explained followed by the two main methods used in the projects; literature review and interviews.

2.1 Research Design

To find out what experience there is within SEP and what may be relevant to transfer and apply in the other country it is essential to find out which experience there is with doing strategic energy planning in Denmark and Sweden. To do this it is seen as important to get some input about the subject from municipalities that are being ambitious and taking action on development of the energy systems in their municipalities, because it is assumed that this is where valuable experience can be found. Therefore a three-step methodology is here applied:

2.1.1 Step 1: Defining the Concept of Strategic Energy Planning

The first step will be to frame the field of the analysis and define how SEP is seen. This contains a review of existing literature about energy planning in municipalities in Sweden and Denmark and literature handling the concept of strategic energy planning. This is done to form a theoretical basis for the analysis and to define which focus areas will be relevant to study further in the analysis of the energy planning in the municipalities.

2.1.2 Step 2: Current Framework for Energy Planning

This step describes the historical development of the energy sectors in each country to see the current status in a historical perspective. The current legislative framework and the energy planning authority levels that the municipalities have to act within are presented to give an understanding of the situation the municipalities are in. This is based on studies of legislation in the two countries as well as secondary literature about the legislating and planning authority levels. Also the official national targets regarding development of the energy sector is described to compare to the level of ambition in the respective municipalities. This will be the foundation and starting point for developing interview guides for interviews with municipal energy planners.

2.1.3 Step 3: Participation of the Municipalities in Energy Planning

This last step of the analysis is based on interviews with energy planners in municipalities in Sweden and Denmark. These interviews will form the main output for development of suggestions and recommendations for strategic energy planning legislation and practices in the two countries. The interviews will be based on the focus areas identified in step 1 and the framework for energy planning in the municipalities uncovered in step 2.

2.2 Literature Review

For the analysis a number of different types of literature have used. For step 1 in the analysis, as described above, some different scientific research papers and projects have been reviewed and used as input for the sketching of the context of the problem and for the definition of the SEP concept. Some articles presenting the historical development of the energy sector in the two countries have been used in step 2 as well as documents about the current status of the energy systems and energy policies. For step 2 primary and secondary literature about the legislation and planning authority levels regarding energy planning in municipalities have been reviewed as well. For step 3 the main input is interviews, but for the preparation of the interview guides and selection of municipalities their local energy planning documents, like energy plans, climate strategies, etc., have been review.

2.3 Interviews

For the research two types of interviews have been used; interview with a researcher within energy planning in municipalities and interviews with municipal energy planners. The researcher interview contribute in step 1 and 2 in defining the concept of SEP and uncovering and describing the framework in where the municipal energy planning is going on. The researcher interview also contributes in step three to underline and verify some of the point mentioned by the municipal energy planners. The interviews with the municipal energy planners mainly fed into step 3, but a few points from here are taken out in step 1 and 2 to give examples of actual cases to support arguments.

All interviews have been performed as semi-structured interviews where an interview guide with a short list of questions have been sent to the interviewee before the interview for them to have time to prepare for the interview. The interview guides served as agenda at the interviews and it was tried to have the form of the interviews as meeting with open guided discussion about the topics in the interview guide and where the interviewees also had the chance to point out relevant issues outside of the interview guide. The interview guides were slightly different between the researcher interviews and the municipal energy planning interviews but covering almost the same topics. The interview guides are attached in the Appendices 9.1 and 9.2. All the interviews have been performed by meeting in person.

The interviewees have been given an abbreviation in the report consisting of three letters where the first letter refers to if the person is a researcher (R) of representing a municipality (M) to easily identify it when reading. The last two letters are the initial letters of the interviewee's name.

2.3.1 Energy Planning Researcher

It has been chosen to include an energy planning researcher from Sweden to complement the background and contextual knowledge of the authors of this project. The authors of this project mainly have experience with energy planning in Danish municipalities, but less in the Swedish municipalities. The main purpose is to give a theoretical input on the energy planning in the Swedish municipalities and to have broader perspectives and thoughts on the role of municipalities in the national energy systems.

The Swedish researcher Jamil Khan (RJK) is interviewed for this purpose. He is working as an Assistant Professor at Lund University on Environmental and Energy Systems Studies. He has a Ph.D. within local renewable energy policy and working with renewable energy policy and governance and political barriers associated with alternative pathways to a low-carbon society.

2.3.2 Municipal Energy Planners

To get the input from the municipal level on what experience they have on strategic energy planning for potential transfer and utilization in the other country three municipalities in Sweden and two municipalities in Denmark have been selected for interviews.

The municipalities are selected based on a number of parameters. It is the intention to study three municipalities from each country with different sizes, populations and natural energy resources to see if that has any significant influence on the planning practices. On the other hand it is also the intension to have municipalities that are having ambitions on renewable energy, reduction of CO_2-emissions etc. and that are actively planning and implementing projects to reach their targets. It is assumed that the municipalities that are active planning and developing their energy systems are those with the most valuable information and experience about strategic energy planning. The following five energy planners have been interviewed for the project.

- Matz Hagberg (MMH), Lund Municipality in Sweden
- Lennart Erfors (MLE), Kristianstad Municipality in Sweden

- Malin Norling (MMN), Malmö Municipality in Sweden
- Jens Christian Kaas (MJC), Køge Municipality in Denmark
- Kasper Ullum (MKU), Ballerup Municipality in Denmark

Copenhagen is included as a third municipality in Denmark for the analysis, but no interview has been conducted with an energy planner in Copenhagen Municipality for this study. There is a lot of material available about energy planning in Copenhagen and the authors have made interviews with energy planners in Copenhagen Municipality for other projects for similar issues that are being used as well.

The municipalities of Malmö and Copenhagen are chosen because they are both geographically rather small municipalities, but with high population and urban densities. Opposite to these there are the municipalities Kristianstad and Køge which are rather large in geographical area but with low populations and urban densities. In between these in the two countries are Lund and Ballerup municipalities with lower population and urban densities than the larger city municipalities, but also with less geographical area and no cost line compared to the large and less dense municipalities. All of the municipalities except Køge Municipality are partners of EnergiÖresund which indicates that they are interested in energy planning and in improving and developing their energy systems. Køge is selected outside the EnergiÖresund project because that is a large municipality with relatively low population and urban density which is not found within the EnergiÖresund partners.

2.3.3 Treatment of Data From Interviews

To analyse the data acquired from the interviews in a structured way the inputs from the interviews will be presented and discussed under a number of interesting topics identified in process of the literature reviews and carrying out the interviews. The inputs from the different municipalities are compared where contrasting and the causes discussed. Possible differences occurring between the two countries or the three different types of municipalities are presented and discussed under these topics as well. The inputs from the municipalities and the discussions of these will feed into the chapter of suggestions and recommendations.

3 The Concept of Strategic Energy Planning

In this chapter the Strategic Energy Planning (SEP) is elaborated and discussed as a concept. SEP is here seen in the context of the transformation of energy systems from traditional fossil fuel dependent systems to renewable energy systems independent of fossil fuels. First, a characterisation of the transition towards fossil independent systems is given based on the CEESA project. Secondly, the role of the municipalities in this transition is discussed and lastly SEP as a concept is discussed based on studies of strategic climate and energy planning in municipalities.

3.1 Transition towards Renewable Energy Systems

As mentioned in the introduction many countries are starting to take initiatives to increase renewable energy production and reduce the greenhouse gas emissions and Sweden and Denmark have official targets for 2050 of respectively being CO_2-neutral and being supplied with 100% renewable energy [17,29]. To achieve these targets the energy systems will have to change significantly on a number of areas. The fossil fuel consumption will have to be replaced with alternative sources of energy, the energy consumption in general will have to be reduced and the energy efficiencies of technologies will have to increase.

According to the CEESA-project (Coherent Energy and Environmental Systems Analyses), analysing 100% renewable energy scenarios for Denmark, up to 80% of the electricity supply will be based on fluctuating renewables and only 20% on biomass based thermal production. The total primary energy production is in this system almost reduced to half of what it is today. See the potential development in Figure 1. The conclusions of this study may not be applied directly for Sweden because of different characteristics of the system but to reduce the current consumption of fossil fuels some of the same approaches may be necessary. This means that the thermal production capacities will have to be highly efficient and flexible to accommodate the large fluctuating production. In this system the traditional base load electricity production is not a good solution. Here, gas turbines will be the most efficient solution because of the high production flexibility. For this purpose either biogas or synthetic gas can be used. For heating, other energy sources will also have to be implemented such as geothermal energy, solar heating, excess heat from industry and large heat pumps [14].

Energy savings are an important part of reaching the energy target as well. According to CEESA mainly the heating demand will have to be reduced but also the traditional electricity demand will have to be reduced. The total electricity demand will increase because of increasing electrification of both the heating and transport sectors. Reductions in energy demand within district heating or electricity will also reduce the need for new renewable energy capacity to replace the fossil fuel production. The transport demand can be maintained at the level of today, but the energy supply has to be replaced with electricity or synthetic fuels [14,21].

Efficiency improvements will be required in all parts of the energy sector. In the heat supply it will be necessary to convert as many buildings as possible to district heating to utilize the potential of CHP and large heat pumps for the heat supply. The production units on the power plants also need to produce at a higher electric efficiency and be more flexible, so they can supply the electricity demand with a fuel consumption as low as possible when there is no electricity production from the fluctuating renewable energy sources. In substituting the fossil fuels from the transport sector, efficiency is one of the key points. Electric cars have a much higher efficiency than traditional petrol cars with reciprocation engines and thereby there by the total energy supply for the transport will be reduced, covering the same end transport demand.

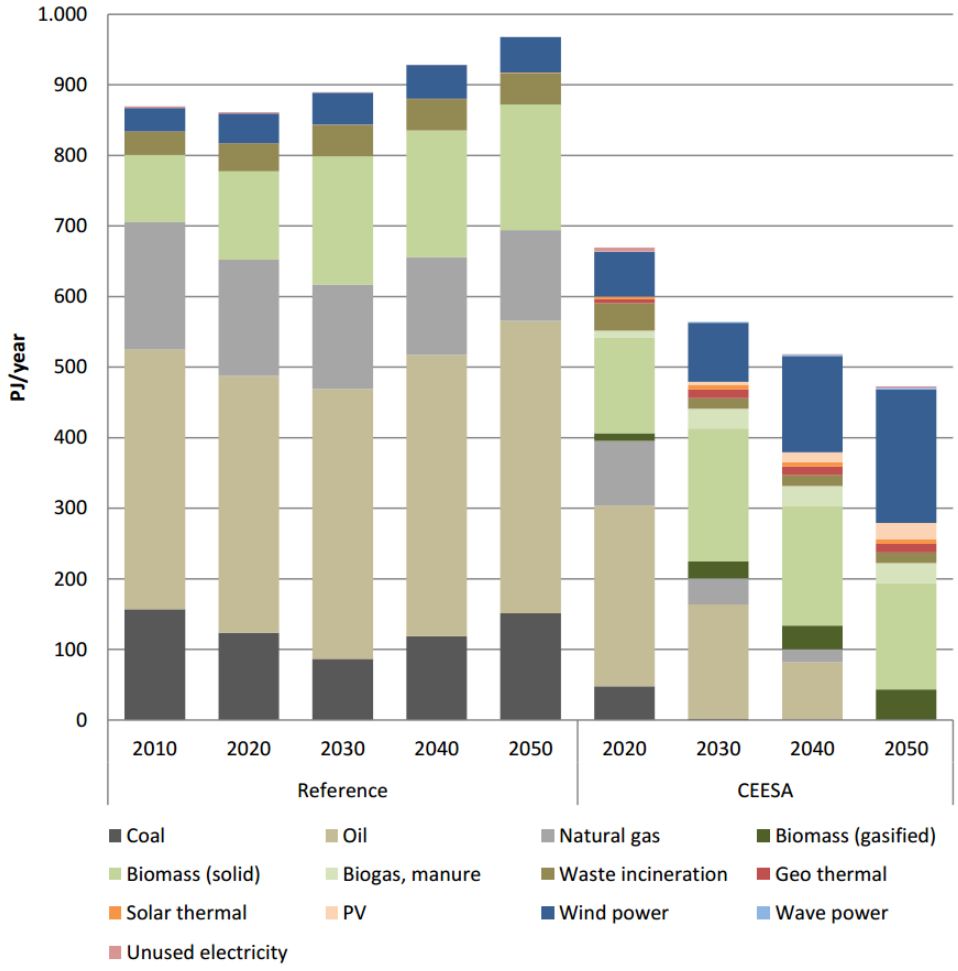

Figure 1: Primary energy supply for Denmark in the reference scenario and the CEESA scenario [14]

The supply of biomass will be a critical issue in a future energy system independent of fossil fuels. Biomass is generally considered as a renewable source of energy, but it is on the other hand a limited resource opposite to wind, solar, wave and other fluctuating renewables. The biomass also has other purposes than for energy supply, such as food, feed for animals, fertiliser, building material, furniture etc. When more area is used for growing e.g. energy crops less area is available for the alternative purposes, so the biomass resources and the use of the biomass should be considered carefully.

3.2 The Role of the Municipalities

The energy systems resulting of the transition described in the preceding section are to a higher extent based on local resources than the current energy systems where the energy production is more centralised. In the traditional system, the fuel is brought into the system from outside as a fuel and transported, stored, converted and distributed to the consumers as petrol, gas, electricity or district heating. In the fossil independent system there will be almost no input of fuel from outside. The production of the energy will be going on locally in the country, such as on shore wind turbines, biogas plants, geothermal energy or solar thermal production. These local energy sources will feed into local energy systems, e.g. a CHP district heating system with a large heat pump. To balance the local energy system an exchange of resources as biomass, manure, electricity, district heating etc. can be going on with the neighbouring regions.

These local processes in the renewable energy systems and utilization of the local renewable energy sources require knowledge about the local systems, potentials and conditions. The municipalities have an important role in this regard as the local energy planning authority to implement projects that will contribute to the national targets. In the municipal energy planning the national visions and targets have to be refined and converted into concrete actions. Here, the local resources and the specific potentials be pointed out and integrated. This could be conversion of heat and electricity production facilities, connection of individual and natural gas heated areas to district heating, potentials of heat savings in housing, utilisation of waste heat from industry and improvements of local and public transportation systems.

What has characterised local energy planning in most countries until recently is the focus on individual components of the energy system. In Sweden, municipal energy planning was in the past mainly driven by local energy companies with a strong focus on the heat supply side. In Denmark, this was accompanied by a strong local wind power movement, which necessitated the establishment of municipal wind power planning. Global initiatives, such as Local Agenda 21, and a changing focus in national energy policies with regard to climate change and supply security, have had an influence on the scope of local energy planning over time. While it can be argued that local energy planning to a certain extent follows national policy goals, local authorities also tend to emphasize those areas in which they possess some ability to act [20]. This means that local energy planning on the one hand has become more comprehensive, including more sectors and components of the energy system as well as taking more policy goals into account. On the other hand, especially municipal energy planning still seems to remain most effective within those fields where local authorities and local energy companies have executive powers; i.e. leading to the implementation of concrete projects. Other areas in which responsibilities are unclear or are with actors other than the local authorities and local energy companies, are less concretely defined and may not lead to the implementation of concrete projects [1].

In both Denmark and Sweden it is voluntary for the municipalities to do actual energy plans, which means that the two countries are in comparable situations regarding the role of the municipal energy planning. [20] have analysed the local energy plans of 11 municipalities in Denmark to what extent they match with the national energy strategies. The study shows that the municipalities are willing to engage in energy planning, but also that they have many different initiatives which not all match with the national strategies. Also [15] has analysed energy planning in 12 Swedish municipalities and concludes that the municipalities are using energy planning very differently and that the reflection of the national strategies also varies greatly.

This indicates that there might be a potential in strengthening the coordination between the national energy strategies and the municipal energy planning to better reaching the national targets. It is also suggested by [20] that the roles of the municipalities and the government in the energy planning are being clarified together with giving the municipalities the appropriate planning instruments for them to be able to effectively carrying out the energy planning within all the energy related sectors. See Figure 2.

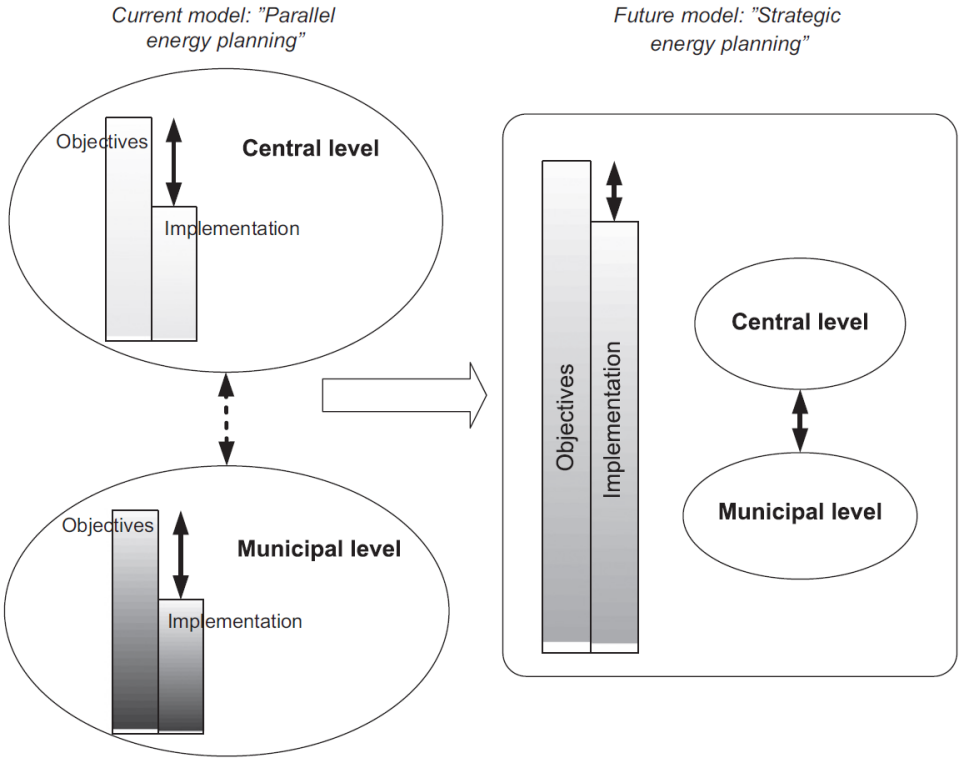

Figure 2: Simplified illustration of the current energy planning system in Denmark and how this system could be adapted to facilitate the transition to a 100% renewable energy system in the future. While there is limited coordination between the state and the municipalities in the current system, in a strategic energy system, there should be a stronger integration of central and local energy planning [20].

3.3 Defining Strategic Energy Planning

Strategic energy planning has not been found to be defined in literature prior to this project and therefore the concept is here defined for the scope of this project seen in the light of the transition towards renewable energy systems and the role of the municipalities in this transition.

In municipal administrations the energy planning relate to several different administration departments, such as electricity and heat supply, transportation, climate planning and spatial planning. Before defining SEP therefore some issues in relation to the nature of energy planning have to be considered. Steidle [21] mentions a number of important characteristics to strategic planning of energy systems. These are summarized here:

- The planning and operation of partial systems are managed by different actors with different and possibly with conflicting interests.
- The relatively long lifetimes of energy infrastructure determines the development for a long time horizon.
- In sectorial divided planning it is not taken into account that partial systems can be interdependent.
- Initiatives on the supply side compete with initiatives on the demand side which should both be assessed.
- The development of socioeconomic factors like the general economy, fuel prices or public regulation influences the choices of long term investments.
- Changes in local energy systems will affect the local residents, industries and the local environment

- Investments in local renewable energy technologies require long term stable demand and commitment.

On the basis of the above mentioned facts concerning strategic planning of energy systems [1] have developed the following five principles of "Integrated climate and energy plans." These five principles will be used to define SEP. Each of the five principals is briefly elaborated here with reference to the above mentioned facts.

- *Long term planning*
  The plan should have a time horizon of at least 30-40 years and contain the possibility of a 100% renewable energy system. This will enable the planning to handle the long lifetimes of energy infrastructure and to cope with the consequences of these. Also large investments in RE technology will be easier to finance and implement with a long term planning because of the more clear future conditions.

- *Based on scenario analyses*
  The plan should be based on scenario analyses including all the energy related sectors: electricity, heating, transport, gas and both supply and demand sides. It should be a techno-economic analysis to ensure that long term goals are implemented in the best socioeconomically feasible way. Using a scenario analysis can also help taking into account the uncertainties of the future development and suggesting possible different consequences of the proposed initiatives.

- *Internal coordination of planning process*
  The different departments in the municipal administration that are working with different aspects in different sectors should be coordinated to avoid a potential sub optimisation of isolated sector plans. An organisational structure should be established to facilitate vertical communication between the different departments in the municipality.

- *External coordination of planning process*
  Energy systems are often covering more than one municipality, e.g. the district heating system of the capital region or regional bus lines, and they should therefore be coordinated with other actors in the municipality or in other municipalities. This could be other municipalities, energy companies or transportation companies. When partial energy systems are optimized within administrative borders potential synergies of cooperation are lost.

- *Local ownership and involvement*
  In local energy planning local ownership and involvement should be promoted because it is important to make sure that the plans can be realised, but also to make the projects benefit the local economy.

The Danish Energy Agency has developed a definition of the strategic energy plan, but with focus on the planning document and not on the process of SEP which includes more aspects than just the planning document as seen above. DEA's definition looks like this:

"The strategic energy plan is a planning tool that enables the municipalities to plan the local energy issues towards a more flexible and energy efficient energy system with the aim to utilise the potential for transition to more renewable energy and energy savings in the most societal energy efficient way.[1] " [24]

[1] Own translation of the definition of "The strategic energy plan" from p. 5 in [24]

As this definition is not sufficiently covering the concept analysed in this study another definition is here suggested. This definition has a focus on the municipalities' role as planning authority in the transition of energy systems. Strategic energy planning is here defined as:

> *The process where municipalities are planning for the development of energy supply and demand within electricity, heating, mobility and other relevant sectors, based on long term scenario analyses, in coordination with the relevant municipal departments and external actors including the local communities, to reach long term societal goals in the most feasible way.*

The definition does not specify the goals of the planning, such as 100% renewable energy, independence of fossil fuels or CO_2-neutrality, but sustainability issues are seen as natural motivations for engaging in strategic energy planning in general.

4 Strategic Energy Planning in Sweden

This chapter covers that Swedish energy system and the empirical data in this regard. The data is presented in three main sections. The first one is presenting the Swedish framework for energy planning where the main inputs are from literature studies. The second section is about how the planning is carried out in the municipalities where the main inputs are from the interviews. The last section is presenting specific suggestions and recommendations for change in policy and legislation. Before these, a short summary of the development and status of the energy supply in Sweden is given.

After the oil crisis in 1979 efforts were initiated to reduce the oil consumption in the country, including a requirement of municipal oil reduction plans, because the energy sector was highly dependent on oil at this point. Renewable energy like hydro power and solar power was being promoted as well nuclear power being introduced. This was both to increase the security of supply and to being able to supply an increasing demand with cheap electricity. In the mid 1980's the focus was changed again. Now nuclear power was prepared to be phased out and more emphasis was put on lasting renewable energy and "rational use of energy." This line continued in the 1990's where CHP for district heating was being promoted and the first nuclear reactor was closed. Subsidies were introduced for CHP and wind power production to make these competitive to fossil and nuclear energy [15]. The question about nuclear energy is still debated and the current government has annulled the phase-out of nuclear power and it is seen as a substantial part of the future energy supply in Sweden [29]. In 2009 the four main primary energy supplies in Sweden was; Oil (32%), nuclear (26%), bioenergy (22%) and hydro power (12%) [29].

4.1 Current Framework for Energy Planning

4.1.1 International/ EU-level

The main international convention with implications on energy planning is the United Nations Framework Convention on Climate Change (UNFCCC) which is an international environmental treaty to prevent climate changes. This is supplemented by the legally binding Kyoto Protocol under the UNFCCC signed by 191 countries and the European Union. The Kyoto protocol aims for a reduction of the global CO_2-emissions of 5.2% and the reductions are distributed so that developing countries do not have to contribute to the reductions. The total reduction target for the EU is 8% towards 2008-2012 with reference to the emissions in 1990. The UNFCCC runs until 2020 with an annual meeting, but the Kyoto Protocol has not been extended with legally binding targets after the first period that ended in 2012 [32].

The EU reduction target is further differentiated within the EU to take into account the different member country's situation and potential for emission reductions. For example, Denmark has been allocated a reduction target of 21% whereas Sweden is allowed to increase the emissions by 4% [28]. To meet the targets the EU established the EU Greenhouse Gas Emission Trading Scheme (EU ETS) that requires large energy consumers, like district heating and electricity producers of a certain size and heavy industries, to have or buy emission quotas for their emissions. The amount of quotas will gradually be reduced towards 2020 to meet the reduction targets [32].

Towards 2020 the EU is implementing the Climate and Energy package, which includes an obligation to reduce the CO_2-emissions by 20% and having a 20% share of renewable energy in the primary energy supply and improving the energy efficiency by 20%. To ensure that the target is reached the so called energy efficiency directive has been adopted. The directive requires the member states to take initiatives to improve the energy efficiency [22].

4.1.2 National Goals for Energy Planning

The long term vision of the Swedish government for the Swedish energy system in 2050 is to have a sustainable and resource efficient energy supply and no net emissions of greenhouse gasses [29]. The energy policy is building on three main pillars; ecological sustainability, competitiveness and security of supply and to realise the long term vision four main objectives for 2020 have been set up:

- 50% renewable energy
- 10% renewable energy in the transport sector
- 20% more efficient energy use
- 40% reduction in greenhouse gas emissions (to 1990-level) [29].

Within the heating supply significant energy efficiency measures should be taken both in households and industries and district heating with CHP will be promoted. In the transport sector biofuels will be promoted and the aim is to have a car stock in Sweden independent of fossil fuel by 2030. The electricity supply is currently based on nuclear and hydro power production and to improve the security of supply these two sources is supplemented by increased renewable electricity production, mainly from increased wind power capacities both on and off shore. A number of research and demonstration projects will be started within e.g. wave power, solar power and gasification of biomass [29].

4.1.3 Planning Authority Levels

The planning systems in Sweden are highly decentralised and the municipalities have a so called “planning monopoly” meaning that other authority levels have no or limited influence on the municipal planning. On the national level, legislation and planning documents are provided giving guidelines for the planning, but the interpretation and detailed planning is being done locally in the municipalities.

Between the national government level and the municipalities there are two different actors; the Regions and the County Administrative Boards (CAB). The role of the county administrative boards is to make sure that national legislation is followed by the municipalities and to develop strategies and guidelines for the municipalities. For example, the CABs have to develop regional energy and climate strategies for the whole county. This should work as guidelines for the municipalities so that the municipalities do not work in different directions with the energy planning and so that potential synergies can be integrated in the municipal planning [5]. The Regions on the other hand have regionally elected boards and are mainly in charge of public transportation and the hospital and health care systems and the planning and development within these sectors [10,16]. Neither the CABs nor the Regions have direct power over the planning in the municipalities.

4.1.4 Legislation and Support for Municipal Energy Planning

In 1977 the Swedish government passed a law requiring the municipalities to plan for energy supply, distribution and consumption. The requirement was not binding in the beginning though, but after the oil crisis in 1979 it was made compulsory, which it still is today. This is the main law concerning energy planning in Sweden and it is not very detailed. There are no measures of how often the municipal energy plan has to be updated and in many municipalities it is not prioritized and the plans are of very different extent [15].

The law requires the municipalities to have a current plan for the energy supply, distribution and consumption which must be approved by the municipal board. For these plans an assessment of the environmental consequences must be provided as well. The municipalities are required to promote energy savings and efficient use of energy and provide a secure supply of energy. It is also stated that the municipalities have to cooperate with other municipalities, energy companies or

other actors where relevant to the plans [30]. A specific requirement in connection to the energy plans is that the municipalities have to make an environmental assessment of their plans, but not necessarily as a separate document though [6,10].

4.2 Participation of Municipalities in Energy Planning

This section presents the results of the studies of the energy planning in the municipalities including the interviews with the energy planners.

4.2.1 Goals and Planning Process of Municipalities

The assessed municipalities each have different goals for the development of their energy systems. Malmö has the most ambitious goal of being supplied with 100% renewable energy by 2030 and a number of partial goals [16]. This is an ambitious goal and MMN says that this will be hard to reach but she believes that it will be possible to do. In Kristianstad the main goals are to reduce the emissions of greenhouse gasses by 40% until 2020 from 1990 and to have a share of 50% renewable energy [6,11]. In the Municipality of Lund there is a new energy plan being developed at the moment and the target in this plan will probably be to reduce the greenhouse gas emissions by 40-50% by 2020 compared to 1990 [8]. Lund Municipality also has a vision of having a sustainable transport system in 2030, but not mentioning details of the energy supply though [13]. None of the municipalities mention targets further in the future than 2030.

The interviewed representatives of the three municipalities disagree on the appropriateness of the level of ambition in the national targets for the energy supply. Some mention that the level of ambition in the national targets reflects all municipalities and not only those with the high ambitions and that the current therefore may be more realistic to reach. Others argue that the national targets should be higher to encourage the municipalities to do more about the transition of the energy sector.

There are large differences in how the municipalities are conducting the planning process. Some develop a number of strategies and plans related to energy in different ways where others develop only one plan that covers all aspects related to energy in coordination with other plans for e.g. climate adaption, environmental or building renovation. There are also differences in how the energy planning function is located in the municipal organisation. In some municipalities the energy planning function is located in a normal department of the municipality, e.g. Malmö [8] whereas in other municipalities the energy planning function is located directly under the municipal council as a function overlapping the other departments to improve the coordination with the other departments, e.g. in Lund and Växjö [8,10].

It is also different how much the municipalities are doing more than they are required to through the legislation on energy planning and environmental assessment of the energy plans. The three municipalities are generally doing more than they are required to within energy planning, but in many other municipalities there are not doing much more than this [10]. RJK says that the municipalities in Sweden are divided in two groups, where the one group is setting goals and taking action where the other group doesn't do more than required [10].

4.2.2 Relation to National and Regional Levels

All the municipalities state that they have higher targets within energy and climate than the Swedish government in one or several issues, and no targets have been identified to be lower than national targets. This means that the municipalities may indirectly be influenced by the national targets, even though only one mentions it.

The regions on the other hand all the three municipalities mention that they have some cooperation or adaption of the regional targets for reduction of greenhouse gas emissions and renewable energy in transport. MLE also mentioned that they had some cooperation with Region Scania

about the development of new infrastructure for busses and dedicated bus lanes in the city of Kristianstad [6].

Regarding the CAB in Scania the municipalities are responding differently. Malmö and Kristianstad are considering and adopting some of CAB's suggestions whereas Lund have planned to meet with representatives from the CAB and other municipalities to discuss potential cooperation and targets for the energy planning [8].

4.2.3 Areas with Well-Functioning Planning and Implementation

There are a number of areas which all of the interviewed planners in Sweden have mentioned independent of each other. They have also mentioned some of the same cases and examples which are seen as a result of the public debate about these topics, but also that these are areas where the Swedish systems and framework is working well.

Transport is one issue that all the interviewees have mentioned. There are many initiatives in the municipalities concerning transport planning and renewable energy sources for transport. All the municipalities have mentioned that they have some biogas supply for the public and municipal cars and busses. Kristianstad have converted all the municipal busses to run on biogas and are working towards covering also an increasing share of the private car transport. They have also built three filling stations for biogas where both public transport and private people can refill and a test project of a school bus running on RME (rapeseed biodiesel) [6].

In the city of Lund they have especially done a lot to encourage the use of bikes by building bike lanes along the roads since Lund is a big student city and many people were already using bikes there. In Lund they have also employed a so called biogas coach that have the tasks the develop the biogas sector in the municipality by doing networking, visiting farmers and industries with wastes with a biogas potential, waste water treatment plants and energy companies.

The efficiency in buildings is also an area that all of the three municipalities mention as an area where they are doing a lot. In Kristianstad an old apartment complex with 1,200 apartments has been completely renovated and energy refurbished including the conversion from electric heating to DH [6]. Also in Lund they have a strong focus on energy efficiency in buildings where they try to keep a good dialogue with the building contractors and in some cases where the municipality own the land they put some minimum building efficiency requirements to the potential contractors for the buildings of that area, which the legislation gives them the authority to do [8].

A public support scheme was initiated by the previous government where the municipalities could apply for money for energy and climate related projects. All of the three interviewed municipalities mention this as a good scheme and that they got support for various projects and that these have started many thing in the municipalities. For having these grants the municipalities were required to have a climate strategy and had to some work in preparing the application which RJK mention was not a problem to the municipalities already doing something on energy and climate issues, but to other municipalities it was harder to do, which resulted in that it was only about half of the municipalities that got support [10].

4.2.4 Areas with Barriers to Planning and Implementation

The municipalities all mention that municipalities tend to compete with each other on a number of issues which creates energy related problems. One thing that they all mention is the location of big shopping centres in the municipalities. The municipalities all wants to have the shopping centres within the boundary of the municipality because of the turnover of the companies and jobs the shopping centres can generate. But as so many municipalities build shopping centres they all seem to work poorly. At the same time the shopping centres are generating a lot of additional transport compared to having the shops in the cities.

MLE also mention that biogas plants and waste incineration plants to some extent generate the same kind of problem because every municipality wants to have the plants within the municipality which creates an over capacity at the plants because there are not enough material for all these plants.

The opposite situation is the case for location of wind turbines. Two of the municipalities mention that it is rather hard to get wind turbines located, both because of strong local opinions against wind turbines for most projects and because the legal process of getting wind turbines approved is rather long.

The three municipalities all mention that the ownership of the infrastructure is an important issue. Malmö Municipality does not own the power and DH production infrastructure in the municipality. E.ON. bought the production equipment from the formerly municipality owned energy company and they now operate the DH plants in the municipality. This means that the DH planning in the municipality is limited to communication with E.ON. They do not have any authority to require certain areas to be supplied with DH, they can only suggest this to the energy company. The energy company on the other hand also owns some natural gas supply systems in the municipality and they do not seem to be interested in converting this to DH, even though the municipality is interested in this. In this regard it is also mentioned that the Swedish branch of E.ON. always listens to their wishes, but cannot always act independently from the mother organisation in Germany [16].

In Lund they have deliberately avoided selling the energy infrastructure to a private energy company the keep as much power over the energy sector in the municipality as possible and to keep the option to do DH planning [8].

In Kristianstad, it is mentioned that the development of new biogas filling stations is a challenge because the municipality would like to have more filling stations to increase the availability and motivate people to buy biogas cars. However E.ON., who owns the infrastructure doesn't want to build more filling stations before there are not enough cars to generate sufficient demand for the service [6].

All the interviewees from Sweden mention the government's current plan of removing the municipality's possibility of placing requirements on energy efficiency in new building projects on lots owned by the municipality itself, as a big problem. The government will remove this possibility because it is seen as too difficult for contractors to build when they are met with different requirements in each municipality. There is a general lack of apartments in Sweden so the government also doesn't want to increase the national building efficiency requirements to encourage building of more apartments. The same situation occurred in the 60's and 70's where the so called million-apartment program was carried out where one million cheap apartments were built with poor insulation and heating systems. These apartments built in this period are now getting to need a large renovation, where some will be energy refurbished but not all. Some may just be torn down. The planners are worried that the politicians will make the same mistake as back then. This policy is a challenge to the energy planning in the municipalities because the heat demand in buildings is defining the energy demand on very long term, since these buildings may be up to a 100 years.

In Lund municipality it is also mentioned that different departments in the municipal administration sometimes have contradicting interests with relation the energy issues which can make it difficult to plan and work in a consistent way when different and changing interests have to be considered and included.

4.3 Suggestions and Recommendations

The recommendations here presented are based on statements expressed by the interviewed people in Sweden. Some of the suggestions are statements of one person and others are general, which will be noted where relevant. Some may also just be spontaneous ideas not fully thought through, but these should be seen as indication of which direction these people see the development should go from their perspective.

All the interviewed people agree that the Swedish government is not being very ambitious in their targets within the energy and climate field. They disagree on whether the targets should be more ambitious as mentioned earlier, but they agree that the government should develop more long term strategies of how the development should go. They also agree that the municipalities' possibility to go further and have higher targets than the government is important.

Positive incentives should be used to engage municipalities in the energy planning. Subsidies for projects or other incentives enabling the municipalities to do thing on own initiative. RJK mentions that the planning monopoly is very strong in Sweden and that the municipalities don't like to have restrictions or prohibition of doing their planning. The restriction in the municipalities' ability to set energy efficiency requirements in buildings is an example of this. MLE suggests that the requirement of the municipalities should be kept but maybe allowing the municipalities to choose between three or four standard efficiency levels to make it easier to the building contractors to navigate in the building efficiency requirements [6]. MMH also suggests structuring the national building regulations as in Denmark where the requirements are gradually increasing during the years, already now determined for many years into the future, which gives contractors, municipalities and other relevant parties the possibility to plan for the long term changes [8].

As mentioned, the municipalities also bring up the need to renovate the large amount of buildings from the 60's and 70's and it is suggested to provide an incentive for the municipalities to support an energy refurbishment of these building while they are being renovated anyway, and possibly convert the heating supply to district heating if possible.

It is also a general recommendation from the interviewed person to encourage the municipalities to cooperate more about energy projects because the energy issues are often, as mentioned, crossing the borders of the municipalities, like the good example of the Regions taking a role in the cooperation about public transport. MMN suggests making subsidies for energy projects that can only be applied for by a collective of three municipalities together. This will give the municipalities a positive incentive to cooperate about energy planning.

RJK suggests study more the situation of the municipalities which do not have much activity on energy and climate planning to assess why this is and how this can be improved. In this connection he also suggests to make the funding application process for small municipalities without a lot of resources or previous work on these issues easier, for them to get a chance to get started.

RJK recommends the municipalities to focus more on the inclusion of the people and communities in the planning, because there is much good recourse here to be gained if they are more involved. It is here also pointed to that municipalities generally focus on large projects that can be implemented by a company or a contractor and doesn't need the involvement of the communities.

5 Strategic Energy Planning in Denmark

This chapter covers that Danish energy system and the empirical data in this regard. The data is presented in three main sections. The first one is presenting the Danish framework for energy planning where the main inputs are from literature studies. The second section is about how the planning is carried out in the municipalities where the main inputs are from the interviews. The last section is presenting specific suggestions and recommendations for change in policy and legislation. Before these, a short summary of the development and status of the energy supply in Denmark is given.

Until the oil crises in Denmark in 1973 and 1979 about 80% of the energy supply in Denmark was covered by oil. In the following decades a transformation of the heat and electricity supply systems was made. The heating supply was being changed away from individual boilers or electric heating to more energy efficient supply systems, mainly district heating and natural gas. The electricity supply was before the oil crises highly centralised, but hereafter changed to a high degree of local production on CHP-units utilizing the district heating systems to reach higher fuel efficiencies. The central power plants were converted to CHP, mainly based on coal. The recent decades there has been a strong focus on renewable energy, especially wind power which now covers more than 30% of the annual electricity consumption. Also biomass for district heating and individual boilers has been promoted a lot and covers a substantial share of the energy supply [23]. In 2012 the main primary energy sources were: oil (38%), natural gas (19%), bioenergy (18%), coal (14%) and wind (5%) [3].

5.1 Current Framework for Energy Planning

5.1.1 International/ EU-level

The international framework relevant for Denmark is equivalent to those relevant to Sweden. Since these are already presented for Sweden they are not presented here again. See Section 4.1.1.

5.1.2 National Goals for Energy Planning

The long term goal in Danish energy policy is to be supplied with 100% renewable energy by 2050. To be able to reach this goal an energy agreement was presented in March 2012, between parties currently constituting a majority of 95% in the parliament. The agreement contains more specific targets and measures for the development in the energy sector towards 2020. The main targets for 2020 are:

- A reduction of 12% of the primary energy supply
- 35% of primary energy supply will be covered by renewable energy sources
- Wind power production will be equivalent to 50% of the electricity consumption
- 10% biofuel in the fuel mix for transportation

The main measures mentioned in this agreement are increasing the energy companies' obligations to initiate energy saving at their consumers, increasing on and off shore wind power capacity by about 2,000 MW, conversion from coal to biomass at the central power plants, promotion of renewable energy sources for heat supply, e.g. geothermal and heat pumps, promotion of smart electricity grids, improving framework conditions for biogas production for CHP and industrial purposes and supporting the development of electric charging and alternative fuel infrastructure for road transport [26].

5.1.3 Planning Authority Levels

In Denmark there are three different planning authority levels; the government, the regions and the municipalities. The authority within energy planning is in practice only located at the government

and the municipalities. The regions are publishing regional development plans which work as guidelines for the municipalities' planning, but these do not contain physical or detailed specifications, so in practice these do not significantly impact energy planning. The regions are able to facilitate coordination of the energy planning between the municipalities though, which some do practice [4,19].

5.1.4 Legislation and Support for Municipal Energy Planning

In Denmark there are not requirement for the municipalities to do coherent or strategic energy planning as such and the legislation for energy planning in the municipalities is primarily connected to the heat supply planning where The Heat Supply Act is the governing act. The purpose of this act is:

- to promote the best socioeconomic and environmental use of energy for heating of buildings and supply of domestic hot water,
- to reduce the oil dependency of the energy supply and
- to promote cogeneration of heating and electricity as much as possible[2] [27]

Within the heat planning the municipalities are the main actor. The municipalities have to perform the heat supply planning in cooperation with local energy supply companies and other influenced parties and the municipal board has to approve all project proposals in this field. In some cases the minister has the authority to overrule the local decisions though.

The municipalities have the authority to plan for a specific type of heating supply in specific areas and prohibit certain other types of supply. For example an area can be designated for district heating and all other types of heating prohibited. The purpose is to secure the investment in pipes by a minimum demand and number of consumers connected to the district heating grid. New projects are most commonly suggested by the energy supply companies and approved by the municipality if it meets the requirements, but the municipality can also require an energy supply company to implement a given project if it is seen as necessary. Project proposals generally have to be shown to be socioeconomically feasible to be approved.

Another important point about the heat supply is that all heat supply companies have to follow the "self-balancing principle" which means that they are not allowed to generate a profit. They are only allowed to have a certain amount of savings and they can only use their income for the operation of the heat supply system, e.g. salary for plant staff, purchase of fuel for the operation or reinvestment in supply pipes. The costs for heat in these district heating areas are generally lower than other heat sources and these heat supply companies are mainly owned by local consumer cooperatives or the municipalities.

As mentioned the municipalities are the main actor within heat planning, but the municipalities are also the authority within the physical planning which is important to the energy planning. This is for example location of on-shore wind turbines, biogas plants or solar thermal plants [7].

5.2 Participation of Municipalities in Energy Planning

This section presents the results of the studies of the energy planning in the municipalities including the interviews with the energy planners. Note that no municipal energy planner from Copenhagen has been interviewed for this study, so the comments about Copenhagen energy planning is based on literature studies and an interview made for another project with an energy planner in Copenhagen Municipality.

[2] Own translation of §1 of the Danish heat supply act.

5.2.1 Goals and Planning Process of Municipalities

The overall goals in the three studied municipalities in Denmark are rather similar. Køge Municipality has an aim of a 20% reduction of greenhouse gasses in 2020 and Copenhagen and Ballerup both have goals of being CO_2-neutral by 2025. On the longer term Copenhagen has a vision of having a 100% renewable energy supply by 2050 [2] and MKU and MJC mention that the goal on the long term towards 2050 is to get independent of fossil fuels, and they also mention that they take their point of departure in the national goals for energy and climate.

The debate in Denmark is currently focused a lot on the CO_2-emissions which have made a number of municipalities set political goals of being CO_2-neutral before a certain time, e.g. Ballerup and Copenhagen in 2025. The concept is not suitable and does not makes sense for all municipalities. MKU mentions that the concept of CO2-neutrality in itself is absurd because a municipality is so dependent of the surroundings and cannot be seen isolated. In this connection it is also mentioned that it will be hard for Ballerup municipality to be CO_2-neutral because there is no significant renewable electricity or biomass production in the municipality that can be exported to cancel out the consumption of fossil fuels in the municipality, and MKU recognises that it will be hard, but sees it as his task as energy planner to find to solution to the agreed policies from the politicians [31].

The municipalities mention a number of cooperation partners for the energy planning activities. Energy companies, local interest organisations, external consultants and other municipalities. Also internally in the municipalities there are cooperating between different departments and with local municipal energy advisory organisations.

There is a big difference in how the energy planning is organised in the three municipalities. In Ballerup one person with 20% of his time on average is doing the core of the energy planning in the municipality, which is the DH planning. Besides this there are a number of people working with climate and energy related campaigns, e.g. for transport and cooperation with companies. In Køge there are more resources for energy planning, where one person works full time with energy planning, and more areas are here also included in the energy planning, like wind power and biogas. In Copenhagen have about five people work with the planning of energy and climate planning.

5.2.2 Relation to National and Regional Levels

Of the studied municipalities none goes above the national target, and it is even stated by the interviewed municipalities that the goals of the government are good. None of the municipalities goes below the national goals as well.

All of the three municipalities also have cooperation with other municipalities about strategic energy planning initiated by the regions [4,18]. MJC and MKU say that the regions have a good role in initiating and inviting cooperation between the municipalities because otherwise the cooperation would be just ad hoc and not well coordinated.

MJC mentions that the current role of the municipalities is better than the previous system, before the structural reform in 2007, because the new system leaves more initiative to the municipalities and he argues that this creates more local ownership of the projects and more engagement by the different actors when it is local initiatives. Because of this he also mentions that the municipalities have a very central role in the development of Denmark towards 100% renewable energy. MKU doesn't express the same satisfaction with the new system, but neither the opposite. He says that a small municipality with rather limited resources and opportunities for energy planning needs to be seen in a larger context because their planning will often be closely connected to actions in other municipalities.

5.2.3 Areas with Well-Functioning Planning and Implementation

An area where all municipalities are doing a lot is public transport. In Køge they have been working both with busses on demand and 3-minute operation of busses in other areas, creating a kiss-and-ride platform and a large parking lot by a train station with a connection to Copenhagen near the highway, all to motivate people to shift to using public transport and limit the use of individual cars [12]. In Ballerup the municipality recently got a price for their work and communication with companies to convince employees in the private companies to use bikes or public transport instead of the car [31].

Also regarding the reduction of fossil fuel use in transport some projects are being carried out, e.g. in Køge they are requiring their contractors to use electric cars as much as possible [12]. Or in Copenhagen where many of the municipal functions are using electric cars, and they are developing the conditions and infrastructure in the municipality for electric cars [25].

In Køge the development of DH systems is working very well after a recent conversion at their CHP plant and an agreement with VEKS (the DH transmission company for the western part of the capital region) about extending the current DH transmission line to Køge DH system and thereby opening the possibility of exchanging heat at certain times.

In Køge they also have a number of specific initiatives to implement heat savings. One thing is that they have a facility called “Det grønne hus” (The green house) where citizens are offered advice for energy savings in their houses or buildings and about energy refurbishment. Another initiative is that they offer carpenters and similar craftsmen an additional education about energy refurbishment of buildings. A third thing to mention is that the costs for the DH in new DH areas are of full variable tariff and no fixed share, meaning that the heat consumption is directly proportional to the heating costs. This increases the economic benefit of doing refurbishment of buildings because the whole price is affected by the savings [12].

MJC also mentions a kind of industrial symbiosis which is being started up between Køge and Solrød Municipalities, Køge DH company, a biogas plant in Solrød Municipality and company in Køge called CP Kelco. This company has a large waste product of orange peels and large gas consumption for process energy. At the same time the neighbuoring municipality, Solrød, is cleaning their beaches for a lot of seaweed which is also just a waste product. The idea is to use the orange peels and the seaweed in a biogas plant to produce biogas. The biogas can then be sent to CP Kelco as supplementary process energy and the company can be connected to the new DH system in Køge and supply a base load of 10 MW. Here many problems are solved and waste resources utilized at the same time. This idea has been formed in informal communication between different stakeholders in the municipalities and the companies [12].

5.2.4 Areas with Barriers to Planning and Implementation

The challenges the two municipalities Køge and Ballerup are of very different nature. Therefore the challenges are described for each municipality separately. In Køge the challenges are related to practical issues and barriers for the implementation whereas in Ballerup the challenges are mostly related to the lack of resources and ability to plan caused by the different physical, organisational and structural conditions for the energy planning in the municipality.

MJC in Køge mentions a problem related to the taxation on waste heat from industries, which means that the project about CP Kelco, described above, is not very feasible [12]. The problem is that the waste heat is taxed when it is fed into the DH systems, and this system hinders the development of waste heat integration in DH. Another challenge to the development of DH in Køge, especially in a smaller decentralised DH-system is that more and more house and building owners within the DH supply areas apply and get exemptions from connection to DH supply because they used the low-energy house regulations. MJC says that this is a problem for the future

development of DH in these areas because the economy of the plants will be poor. A last problem that MJC mention is that the location of wind turbines is very strongly influenced by public opinion, and the politicians are afraid of not getting re-elected, especially in the time before municipal elections [12].

In Ballerup one of the biggest challenges to the energy planning is the limitation in resources for doing the energy planning. MKU says that they need more resources for doing energy planning if they should be able to do much more because that is a limitation to them. Another resource limitation to the energy planning is the natural resources in the municipality and there by the potential of increasing the local renewable energy production. In Ballerup there is no space for any wind turbines or any significant amount of biomass production since there is no farm land or the like. Another factor that limits the ability of Ballerup Municipality to plan the energy supply is that the local energy production and distribution equipment have been sold to the German energy company E.ON. which have conflicting interests with the municipality. The municipality wants to change the DH systems from the local ones operated by E.ON. and connect these to the Vestforbrændingen[3] distribution systems, which can supply much cheaper heat to the consumers, including the municipalities own facilities. This will also reduce some of the natural gas consumption used at E.ON.'s plants [31].

A last barrier mentioned by MKU is the complicated regulations regarding district cooling. They have been trying to establish a district cooling system because there is a large demand, but the regulation on the area have so far hindered this development [31].

5.3 Suggestions and Recommendations

The main suggestions and recommendations from the municipalities also come in two groups as with the challenges described above related to the different situation of the two municipalities, and the recommendations are very much in line with the issues mentioned as challenges.

From Køge the recommendations are of a structural character. One recommendation is to adjust the taxation on waste heat supply to generate a stronger incentive to integrate this in the DH systems. Another recommendation is to remove or restrict the possibility not to connect houses within DH areas to DH because of low temperature standard, because this is limiting the feasibility of the DH and reducing the total socio economy [12].

The recommendations from Ballerup are more of an institutional character. It is recommended that there are provided more clear guidelines for the municipalities on how they should act to contribute to the realisation on the national goals more than just reducing CO_2-emissions and thinking in the fact that the municipalities are very different in many ways. He also suggests that the requirements for the municipalities may be more specific to make sure that the area is allocated enough resources in the municipality. A last thing that is mentioned as a recommendation is developing the legislation on district cooling to open that possibility more for the municipalities to work on [31].

[3] Incineration plant that has the capacity to supply district heating in Ballerup Municipality.

6 Discussion

In this chapter the results presented in the previous chapters will be discussed. Some methodological implication realised during the process is discussed first. Hereafter the different circumstances of the energy planning is discussed and the implication of this to the planning leading to a summary of the main suggestions and recommendations proposed by the interviewees of the study. Finally, a discussion of the possible transfer of knowledge and experience between Sweden and Denmark is given followed by a discussion of how this study can improve SEP referring back to Chapter 3.

6.1 Implications of choice of methodology

By choosing a municipal civil servant involved in the energy planning of the municipalities, instead of a local politician working with the energy issues, there are a number of benefits, e.g. the energy planner knows to a greater extent what actually is being done and how the goals and targets are being converted into projects and what the real practical barriers and challenges are. But an issue that turned up during the execution of the interviews is that many energy planners also don't have the full overview of the energy related projects, activities and processes going on in the municipalities. Many people are often connected and working with different issues individually not knowing about all the other projects. This means that some details of the energy planning might not be covered with the interviews. To cover all aspects thoroughly a case study with several interviews would be necessary.

The choice of ambitious municipalities within the energy and climate issues was done to have municipalities with a lot of experience to gain and draw lessons from, but RJK mention that these municipalities might face other challenges and barriers and might also have other opinions on the setting of national goals etc. This means that the recommendations of this study may not reflect those which might be proposed by less ambitious municipalities. RJK suggests that a separate study should be done to analyse the situation and opinions of these municipalities, because these are equivalently important to get to do SEP.

6.2 Different Conditions for Planning in the Municipalities

The circumstances in the municipalities for doing energy planning showed to be very different as expected from the choice of municipalities. The differences have been divided in two sections according to the differences between the two countries and between the different types of municipalities.

6.2.1 National Differences

Between the two countries there are some clear differences in the framework for energy planning in the municipalities. One thing is the level of ambition for the national energy systems and here from following involvement in the energy planning. Recently in Denmark the national goal has been set for the country to being supplied completely by renewable energy by 2050. I Sweden the amount of renewable energy is already about twice as high as in Denmark, but there is no national policy of 100% renewable energy in Sweden. The target is to be CO_2-neutral by 2050 keeping nuclear power in the supply and using carbon capture and storage. Some of the planner mentioned that these lower ambitions also mean that the municipalities generally are having lower ambitions. Also the actions of the government are not encouraging the Swedish municipalities to be proactive on energy issues, e.g. by planning to remove a possibility of the municipalities to put energy efficiency requirements on new buildings in the municipalities without necessarily increasing national requirements.

In Denmark there is a relatively long tradition of legislation and requirements on the municipalities about heat planning, wind power planning etc. In Sweden the planning monopoly is relatively strong and the state is not interfering in the planning as much as in Denmark, so this also creates a

different situation for the municipalities. Some of the planners mention that the planning monopoly is both good and bad in the sense that the municipalities are a bit isolated and that the municipalities tend to compete each other, e.g. on building shopping centres, biogas plants or waste incinerators. In Denmark both of the interviewed energy planners mention that they don't want to do things that conflict with the neighbour municipalities' interests and one even mention as an example that they don't want to build a biogas plant if the neighbour municipality is building one on the other side of the border because that will not be feasible for any of them.

6.2.2 Resource Differences

The studied municipalities are, as mentioned, chosen because of their different sizes, populations and urban density to assess the possible implication of these to the goals and planning in the municipalities. The results indicate some differences between the municipalities. The two municipalities with relatively high populations and urban densities, seems to have higher levels of ambitions than the other municipalities even though the natural resources and production of bio material is lower than the others. In the municipalities Køge and Kristianstad there are being implemented a wide range of different projects and initiatives using some of the natural resources in the municipality, but the goals are relatively low compared to what the goals mentioned for the first two municipalities. For Ballerup the goals are also high for the amount of available resources whereas in Lund the ambition is lower than Malmö and at the same level as Kristianstad.

This indicates that the available natural resources compared to urban area are not an important factor in the setting of goals and initiation of activities in the municipalities. For explaining the differences the goals and initiation of planning activities be distinguished. The reason for the different level and variety of initiation of projects may be related to the economic resources allocate for the energy and climate planning in the municipality, whereas the goals are often more of a political issue related to branding of the municipalities and not always connected to the economic resources allocated for the area.

Another important factor in the setting of goals, level of ambition and planning of activities is the human resources of the civil servant in the energy planning departments. It is mentioned by several interviewees that the people in the energy planners in the municipal departments have a large influence on the setting of goals and initiation of projects because these always have different knowledge, experience and personal ambitions for the municipality which can change the planning a lot.

6.3 Summary of Main Recommendations and Suggestions

In Denmark the recommendations are mostly related to specific regulatory issues, whereas in Sweden they are mostly related to the role of the government in the energy planning.

In Denmark what is recommended by the municipalities is generally that the government should put forward more specific guidelines of how municipalities with different resources and different preconditions should contribute to the national development towards 100% renewable energy. A number of specific regulatory proposals are suggested by the municipalities to improve their energy planning. The first suggestion is to make it a national requirement for the municipalities to have energy plans and strategies, to make sure that a minimum of resources is allocated to this area. A number of suggestions relate to the regulation and taxation of DH connection of low energy buildings, inclusion of waste heat in DH systems and the integration of district cooling.

In Sweden the municipalities have recommended the government to be more active in the long term energy planning and to give the municipalities more incentive for contribute to the long term development of the national strategy. E.g. creating incentive for energy refurbishment of the large apartment complexes from 1960's and 1970's which will soon need a general renovation. It is also recommended to set more ambitious goals for the development of the energy sector in general, but

still letting the municipalities doing more than required. Specifically it is suggested to leave a possibility for the municipalities to require a certain efficiency standard in buildings, but it may be modified to make it easier for contractors to build new apartments. It is also suggested to do more to encourage municipalities to cooperate about the energy planning and to do an effort to include the municipalities that have not already started doing a lot of work on energy and climate planning.

6.4 Possible Transfer of Knowledge between the Countries

This section is based on the positive experience in the municipal energy planning in the two countries. The issues presented here are those in which there are good experiences in the one country, but not in the other because this indicates a possibility of a transfer of knowledge.

6.4.1 Energy Efficiency Building Codes

A possible transfer of knowledge could be the building codes for energy efficiency in Denmark which have been decided on a long term so that the energy efficiency requirements of new building are gradually increased during the years. This allows building companies, citizens, municipalities and others to prepare plans and budgets for future building projects. As all the municipalities in Sweden ask for both higher national requirements and the possibility of setting higher requirements locally, the Danish model may be a good solution.

6.4.2 Long Term Goals and Strategies

Another possible transfer of knowledge is that the clear vision of the Danish government, a 100% renewable energy supply in 2050, seems to settle some questions for the municipalities. All the three analysed municipalities in Denmark have rather similar and ambitious goals and seek to reduce greenhouse gas emissions and increase the share of renewable energy production, in line with the government's vision. The analysed municipalities in Sweden are on the other hand asking for more clear strategies and ambitions to improve the coordination and possibly also the ambitions of the municipalities.

6.4.3 Renewable Energy in Transport

In Sweden there has been a stronger focus on the transport and the renewable energy supply for transport. This is both in the national targets but also in the municipalities. This has led to a much wider development in alternative energy for transport in Sweden. It has been given by law that all filling stations should provide bioethanol, many busses in the municipalities have started to use biogas and tests with biodiesel. All Swedish municipalities mention that they are doing activities about alternative energy sources for transport. In Denmark the focus within renewable energy for transport has only been focused on electrification of the transport and none of the municipalities here mention alternative energy sources for transport other that electric cars. The CEESA project suggests that the light vehicle transport should be on electricity, but heavier transport on a different energy source, possibly a liquid synthetic methanol, but there is not as much experience with other alternative fuels in Denmark, so that could be a possibility to focus more on other types of transport energy systems than electricity to start the development more.

6.4.4 Energy Investment Support Scheme

The investment support scheme used in Sweden until recently, provided by the government, for projects within energy and climate is mentioned by the municipalities to have started a lot of different initiatives in Sweden. Both employments of people, energy renovations, conversion and change of energy supply technology etc. This may be implemented in Denmark as well to support municipalities that wants to do more than they have the economic resources to do, e.g. Ballerup Municipality. This also makes sure that the money is spent locally for relevant projects in the local context.

6.4.5 Environmental Assessment of Energy Plans

Even though the environmental assessment system may not be structured in the optimal way in the current form in Sweden, it may be worth implementing in Denmark as well. J. Ivner (2009) shows that the focus on environmental issues in the municipal energy plans have been strengthened since the implementation of this requirement in the Swedish legislation [9]. This means that even though all municipalities may not have improved their environmental focus, the general trend is that it has been improving. The requirements may be stated more specifically than they are in Sweden today leading the municipalities in the direction of the most important topics to improve the quality and relevance of the environmental assessments.

6.4.6 The Role of the Regional Level in Energy Planning

A last possible transfer of knowledge is concerning the role of the regional level in the energy planning. The municipalities in Denmark expresses that they are satisfied with the role of the regions, where they do not have a direct planning authority but doing some work to coordinate the activities between the municipalities on the regional level. The facilitation of cooperation between the municipalities may help the municipalities realising their role and opportunities in contributing to the national development. In Sweden the municipalities a working more independently than in Denmark so the need for coordination may be larger here and with the planning monopoly in Sweden it may be more reasonable for the regions to have a facilitating role as in Denmark, compared to actual planning authority.

6.5 Development of Strategic Energy Planning in Denmark and Sweden

In this section the results of the analysis are related to the theory about SEP presented in Chapter 3 and the long term development of energy systems is discussed in this context.

6.5.1 The Roles of Municipal, Regional and National Level in Energy Planning

In Section 3.2 the role of the municipalities in the strategic energy planning is discussed in connection to the development of energy systems towards renewable and sustainable energy systems. In Figure 2 it is suggested how a more integrated planning between state and municipalities can improve the implementation of the objectives of the national as well as local targets of the energy planning. Sperling et al. argues that there is a need for both a centralisation and a decentralisation of the energy planning and creation of a synthesis between the two currently “parallel” levels into a strategic energy planning [20].

This is supported by this study where the municipalities of both the Danish and Swedish municipalities are asking for more clear guidelines from the government on how strategies should be implemented to contribute to the development of the energy systems in the most efficient way. Some of the problems caused by this parallel planning occur in e.g. taxation that hinders integration of waste heat from industry, establishment of district cooling systems or municipalities not coordinating location of biogas plants.

In Denmark some of the regions are taking the initiative to develop strategic energy planning projects to strengthen the regional development within the energy sector and to improve the cooperation between the municipalities, but there is a need to have an integration of the energy planning in the municipalities in a more structured way to make sure that all actors are working in the same overall direction and for the same goals. The same is the case in Sweden where both the CAB’s and the regions are developing some regional energy and climate strategies, but it is not binding for the municipalities to follow these and there is some uncertainty in the municipalities on how the two regional actors relate to each other and what their responsibilities are within the energy planning, which shows that there is a need for integration here as well.

6.5.2 Conceptual Organisation of Strategic Energy Planning

The conceptual model of the organisation of SEP suggested by Sperling et al., shown in Figure 3, is developed as a model for the Danish system, but it can be argued that this model is also suitable for the Swedish system. The same actors are involved in the planning process and the same tasks and relations are in play.

One thing that may be added to the model is the role of the regions in energy planning. At the regional level there is some knowledge of the conditions and resources in the region which may be utilised and benefitted from in the planning process. The regions should not have direct planning authority, but work to facilitate the cooperation between the municipalities. This may be relevant in Sweden as well as Denmark and the municipalities express a wish for more inter-municipal or regional cooperation and the role for doing this may be held by the regions. By placing this role by the region instead of e.g. the CAB's may also give a stronger ownership and involvement locally.

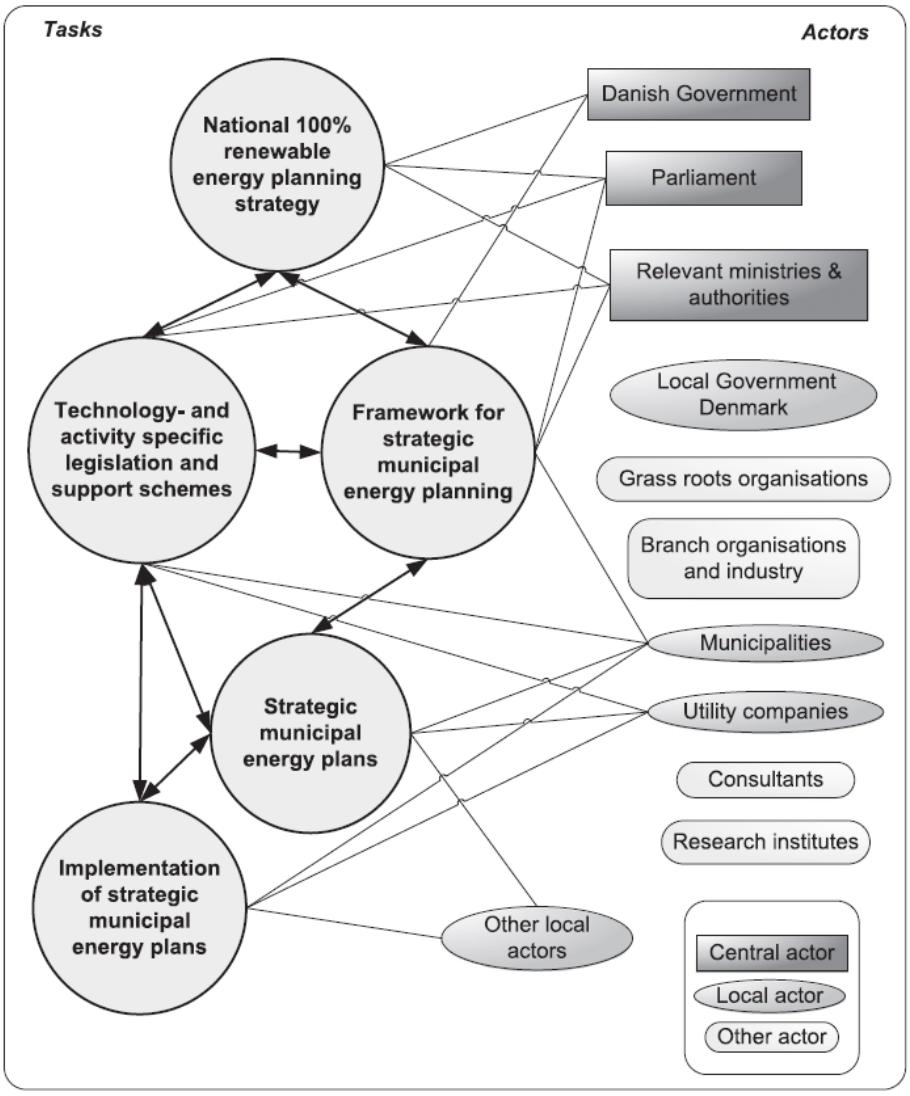

Figure 3: Outline of a strategic energy planning system as an example of how the discussion of concrete energy planning responsibilities in the context of 100% renewable energy systems can be approached [20]

7 Conclusion

The new situation and role for the municipalities in the development of renewable energy systems has been studied in this project with the focus on the municipalities' ability to act within the given frameworks in Sweden and Denmark. This includes the legislative framework for the energy planning in municipalities and how the municipalities actually are working and which challenges they face in the planning. This has been done to generate recommendation for the future work with SEP in the municipalities.

As a starting point for the analyses the concept of SEP has been presented and discussed. Central points identified here are used in the further analyses. For the analysis of the problem reviews of the Swedish and Danish legislation relevant to energy planning have been studied together with the national policies within energy supply. Following this six interviews have been performed to get some empirical input on how the municipalities are working with energy planning and what is working well with the planning, which challenges they face and what they would recommend to improve their energy planning. To supplement these energy plans and strategies of the six case municipalities; three municipalities from Sweden and three from Denmark, have been studied. Lastly the inputs from the municipalities are summarised and discussed.

7.1 Policy Recommendation

The municipalities in the two countries have a number of recommendations for changes in the regulation, taxation and organisation of the planning levels. The recommendations from the two countries are presented separately since there is some difference in the focus.

Denmark:

- The government should put forward more specific guidelines for the municipalities on where to focus the effort in the planning to contribute most efficiently considering the different resources of the municipalities.
- Implement a national requirement of strategic energy planning in the municipalities
- Make sure that specific regulations concerning the energy planning in the municipalities are supporting the development towards a renewable energy system.

Sweden:

- The government should be more ambitious on the development of the energy supply and give municipalities incentives for going further with the development of the local energy systems.
- There should be better incentives both for building energy efficient building and doing energy refurbishment when buildings are being renovated.
- Municipalities should be encouraged to cooperate more on energy issues, e.g. by having funds that have to be applied for by a group of municipalities together.

7.2 Possible Transfer of Knowledge

The suggestions in this section are based on the positive experience in the municipal energy planning in the two countries. The issues presented here are those in which there are good experiences in the one country, but not in the other.

- To use the Danish experience with having an ambitious national energy strategy with a vision of 100% renewable energy, in Sweden.
- To use the Danish experience in the regions on coordinating and facilitation cooperation between municipalities about energy planning, in Sweden.

- To use the Swedish experience of having energy investment support scheme for implementation of plans and projects, in Denmark.
- To use the Swedish experience with environmental assessment of energy plans in Denmark.
- To use the experience in Denmark with a progression in time in the building energy codes, in Sweden.

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9 Appendices

9.1 Interveiw Guide for Municipal Energy Planners

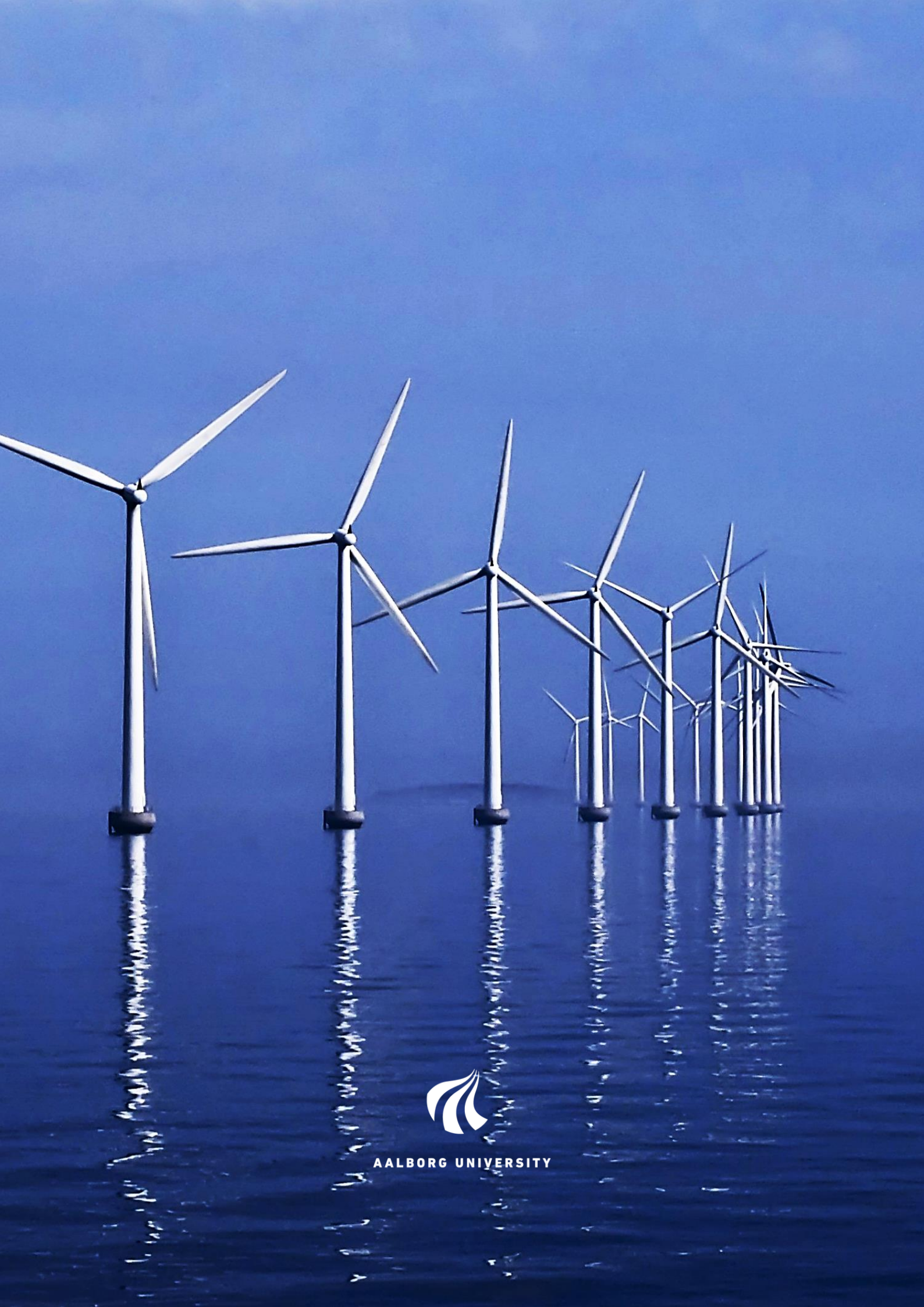
For interviews with energy planners in selected municipalities, about strategic energy planning in Sweden and Denmark

1. How is the energy planning process in the municipality?
   - The process?
   - Which methods?
2. Who is involved in the energy planning?
   - Planners
   - Other departments of the municipality
   - External?
3. Which areas is the energy planning covering?
4. In which areas are the planning and implementation working well?
   - Why?
   - Can you bring out some examples of good results of the energy planning?
5. Which challenges and barriers do you experience in connection to the planning?
   - Areas where you would like to do more but are hindered?
   - Areas where you experience legal or other structural problems to the implementation?
6. How do you see the role of the municipalities in the realization of the national targets?
   - How do you relate to these in the planning?
   - How do you relate to the county's energy planning in you planning?
   - Could you as a municipality possibly contribute more effectively to the realisation of the national targets?
7. How would the best possible situation be for you as energy planner?

9.2 Interview Guide for Researchers within Municipal Energy Planning

For interview with energy planning researcher, about strategic energy planning in Sweden and Denmark

1. What are the planning requirements for municipalities concerning energy issues?
    - Which areas are included in the planning?
    - By law / by practice?
2. Who are involved in the energy planning?
    - To which extent other departments of the municipalities?
    - Other municipalities or stakeholders?
3. How are the municipalities' goals for energy planning defined?
4. Where do you see the strengths of the municipalities in the national energy planning?
5. What are the main challenges and barriers for the municipalities in the energy planning?
    - Areas where they would like to do more but are hindered?
    - Areas where they experience legal or other structural problems to the implementation?
6. How do the goals and measures of the municipal energy planning relate to national and county (Länstyrelse) level energy planning?
7. Could the municipalities possibly contribute more effectively to the realisation of the national targets?
    - Maybe even doing more than the national targets points to?
8. What would be the optimal conditions for the municipalities in energy planning to develop the energy system in a more sustainable direction?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